Space Weather Technical Forecast

Issued on Friday 22 November 2024 at 01:26 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing S1/Minor Solar Radiation Storms with a Slight Chance of R1 throughout. Periods of Slight Chance of G1 to start and end forecast period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the past 24 hours, with background C-class flares. The largest of which was a C5.9 at 21/1807.

There are currently up to ten sunspot regions on the disc, two of which are unnumbered. The main regions on the disc at present include AR3901 in the southeast, which shows significant magnetic complexity. The unnumbered region in the southwest appears to have developed quickly, and is one to watch. Significant magnetic looping over the eastern limb suggests that there are further spots to rotate onto the Earth-facing disc. The first becoming visible in the southeast and has been initially classified as a Axx, although given its location is currently difficult to analysis. The majority of the remaining groups are simple and with little magnetic complexity.

Solar Wind / Geomagnetic Activity: Solar winds at L1 measured by ACE have seen fairly steady Slow to Slightly Elevated regime, with solar wind speeds 370-400km/s. The solar wind density was sitting at near average or just above for much of the 21 Nov, easing to below average towards midnight UTC. The IMF was variable, with Weak to Moderate, peaking at a Bt of 10nT at 21/1333 UTC. The north-south component generally Weak but variable, currently trending positive, ranging between +8 and -6nT. The phi angle favoured mainly negative (towards the sun), possibly as we transition towards the negative CH. Quiet to Unsettled geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 saw S1/Minor Radiation Storm, and continuing to trend upwards.

High energy electron flux (greater than 2MeV) observed by GOES16 was mainly at Normal Background levels. The associated 24-hour fluence remained below the Active threshold with a falling then level tendency, and the 24-hour integrated flux observed at 22/0001UTC was 1.32e6.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a slightly falling Chance of M-class flares with the departure of two recent larger sunspot groups.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

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CH93- and subsequently CH94- are forecast to bring increased solar winds with a Slight Chance of G1 on Day 1 (22 Nov) and again from Day 3 (24 Nov), although Active geomagnetic intervals are considered a more likely maximum.

Energetic Particles / Solar Radiation: Ongoing S1/Minor Solar Radiation storms are expected to continue through Day 1 (22 Nov) following on from a proton storm from around the western limb, possibly from Ex-AR3889. Proton flux levels are likely to take a few days to recover back to background levels from this event.

High energy electron flux is likely to remain Normal Background, with a Slight Chance of Moderate levels on Day 2 (23 Nov). The associated fluence is expected to remain below the Active (1e8 integrated flux) threshold.

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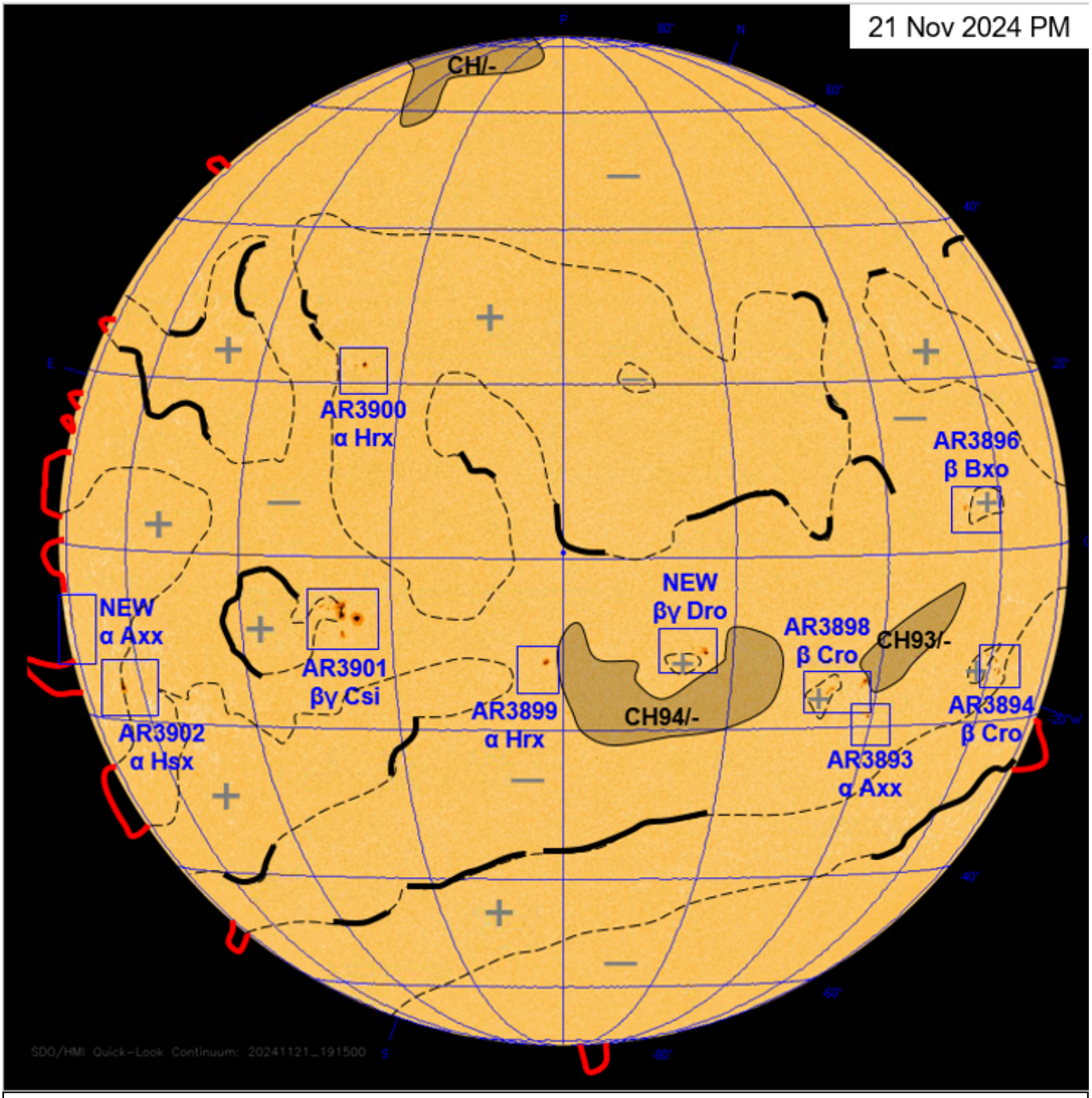
Figure 1: Solar Synoptic Map valid 21/1900 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are currently no Earth-directed CMEs in the forecast. A filament eruption from the southeast disc at 21/0100UTC has been modelled and initial assessments appear to show a close miss later in the UTC day of Saturday 23 November, to no effect at Earth. A broad and fast CME can be seen in imagery leaving from around the western limb around 21/1800 UTC. This has been analysed and we are waiting on MOSWOC modelling to determine the path. However, there is reasonable confidence given its location around the western limb, that it will miss Earth.

Geomagnetic activity is therefore expected to be dominated by emerging fast winds, firstly from CH93- and subsequently CH94-. The former now appears quite tenuous in imagery (e.g. AIA211) but was more visible before midweek UTC - when the solar wind that is due to affect Earth departed the Sun. A Slight Chance of G1 is maintained for this feature, during Day 1 (22 Nov). A lull should then ensure before any subsequent fast wind arrives from CH94/-. This is expected to be the more noteworthy of the two features, with speeds of perhaps 550km/s, however it carries negative polarity which is generally less potent at this time of year and Earth is in any case now nearing the semi-annual minimally potent solstice.

Generally Quiet (Kp0-2) to Unsettled (Kp3) with a Chance of Active (Kp4) geomagnetic activity through Day 1 (22 Nov), becoming Quiet (Kp0-2) to Unsettled (Kp3) by Day 2 (Nov 23). Then increasing again to Unsettled (Kp3) to Active (Kp4) by Day 3 (Nov 24). With a Slight Chance of G1/Minor Storm on Days 1 (22 Nov) and from Day 3 (24 Nov).

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	1	20	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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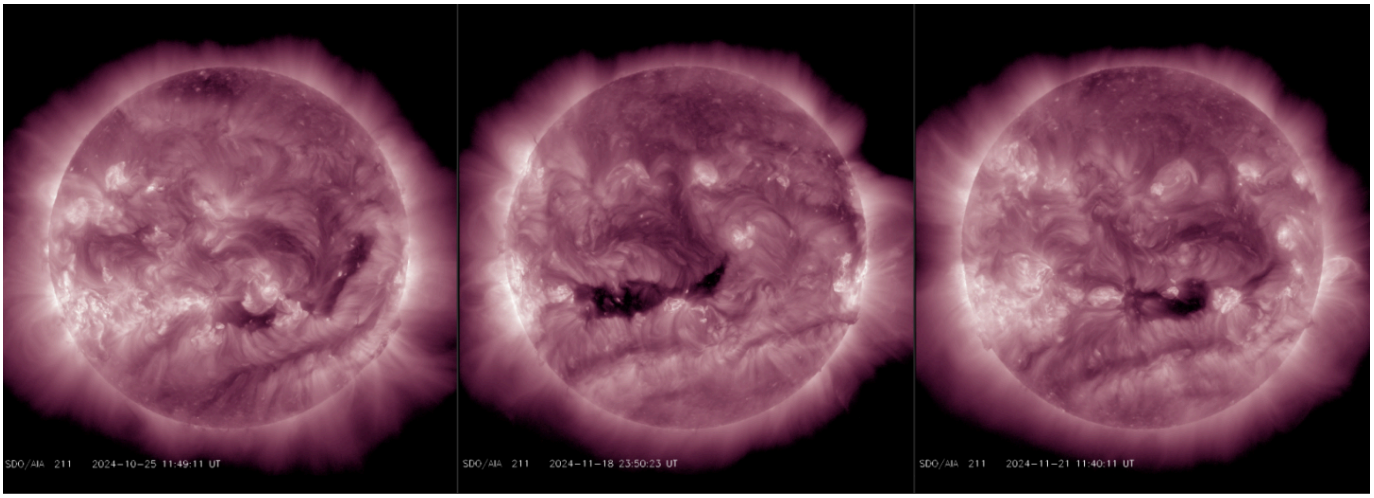
Figure 2: Series of views of coronal holes CH93/- and CH94/- and their predecessors. From left to right: last rotation on 25 October; current rotation on 18 November, nearer the time the solar wind that will affect Earth departed the disc and with fewer viewing angle constraints; current appearance (showing faint appearance of CH93/- in particular).



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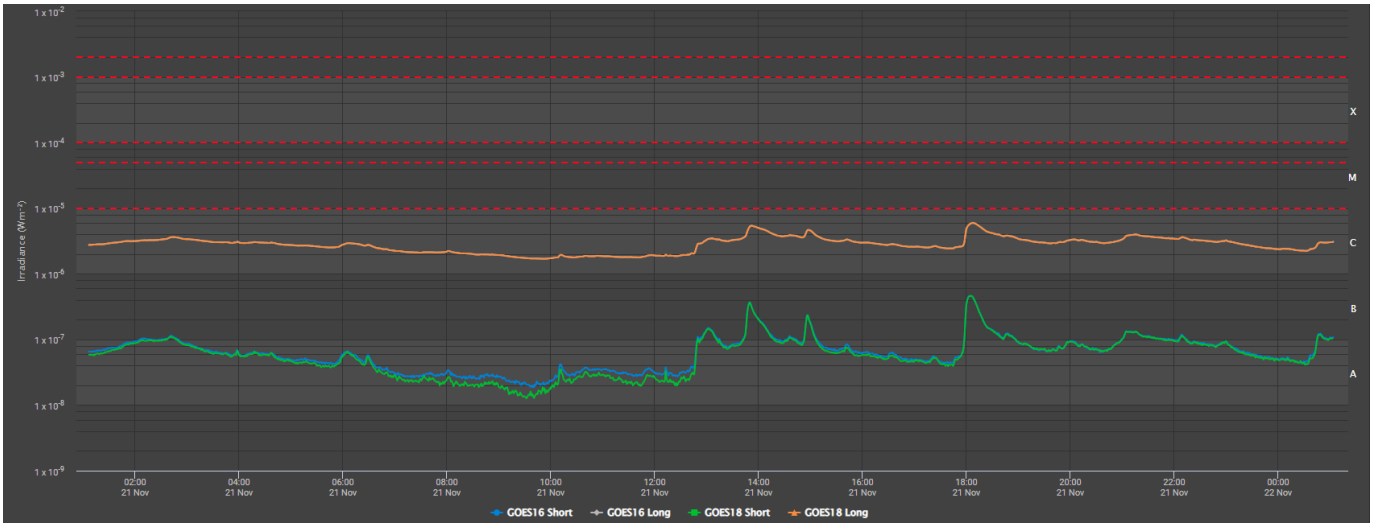
Radio Blackouts - X-Ray Flares

There are currently up to ten sunspot regions on the disc. The main regions on the disc at present include AR3901 in the southeast, which comprises several symmetric penumbral leading spots, some of which have proliferated and migrated west in the period, with small trailing spots and pores. This region has filaments strung through its trailing portion and is one to watch should it flare for CME risk. The unnumbered region in the southwest appears to have developed quickly, previously a Bxi, but with noticeable umbra developing on both the leading and trailing spots, and as a result has been upgraded to a Dro. Significant magnetic looping over the eastern limb suggests that there are further spots to rotate onto the Earth-facing disc. The first becoming visible in the southeast and has been initially classified as a Axx, although given its location is currently difficult to analysis. The majority of the remaining groups are simple and with little magnetic complexity.

Solar activity has been Low during the past 24 hours, with background C-class flares. The largest of which was a C5.9 at 21/1807. Low to Moderate activity is expected, with a now-decreased Chance of isolated Moderate flares. Due to ongoing S1 Solar Radiation storms the probabilities of proton storms are above raw values.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	40	40
Very Active	R3-R5 (X Class)	No	1	1	1	1

Figure 3: X-ray trace showing Low solar activity.



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Solar Radiation Storms (High Energy Protons)

Ongoing S1/Minor Solar Radiation storms are expected to continue through Day 1 (22 Nov) following on from a proton storm from around the western limb, possibly from Ex-AR3889. Proton flux levels are likely to take a few days to recover back to background levels from this event. A Chance of S1/Minor Solar radiation storms by the end of the period as the remainder of the Earth-facing disc is largely unipolar or simple bipolar groups, and does not add any appreciable risk to the daily probabilities of S1.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	100	70	40	20
Very Active	**≥ S3 ***	No	20	10	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton Flux.

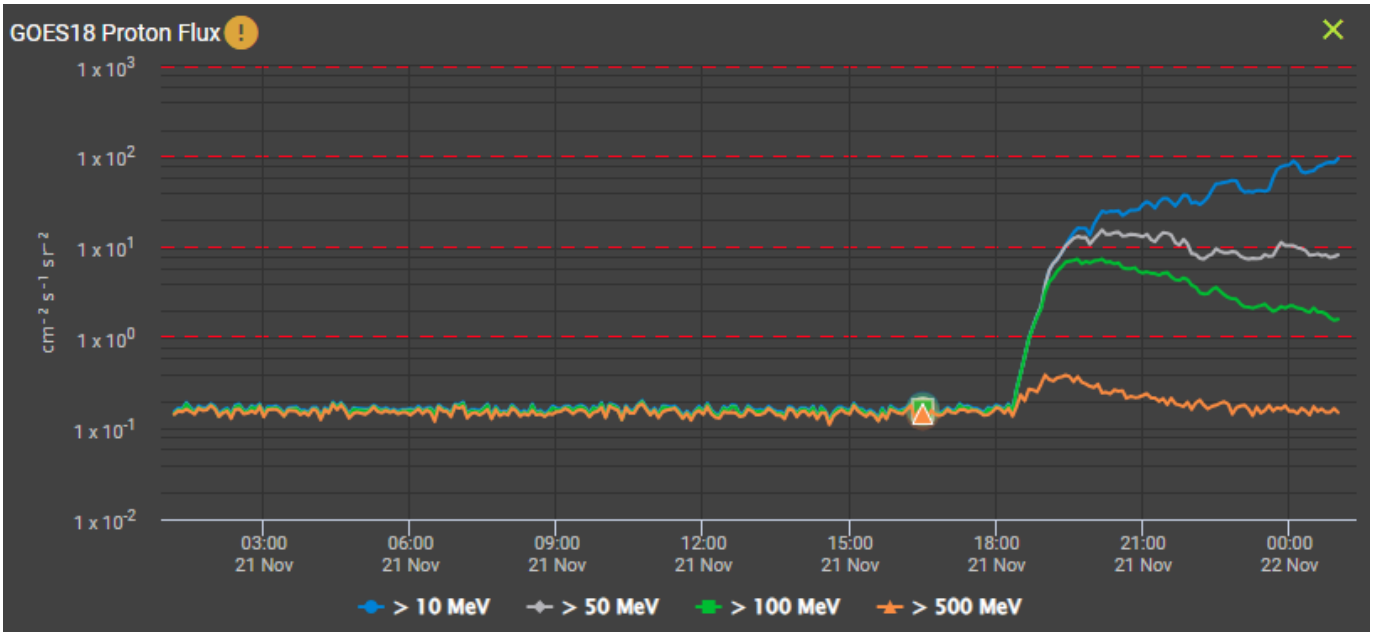

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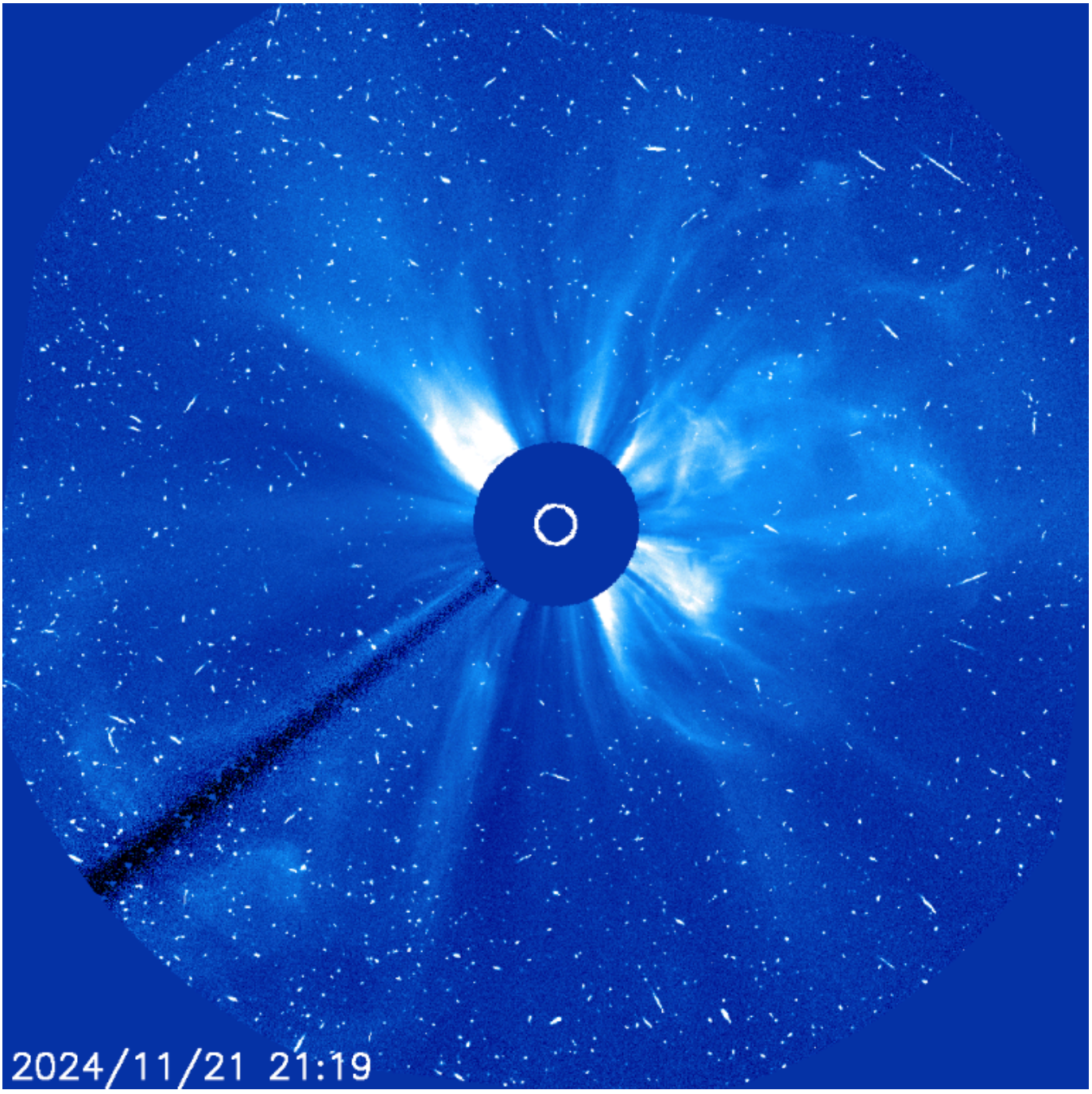
Figure 5: LASCO 3 showing Proton swarms (speckled dots) following a CME from around the west limb.



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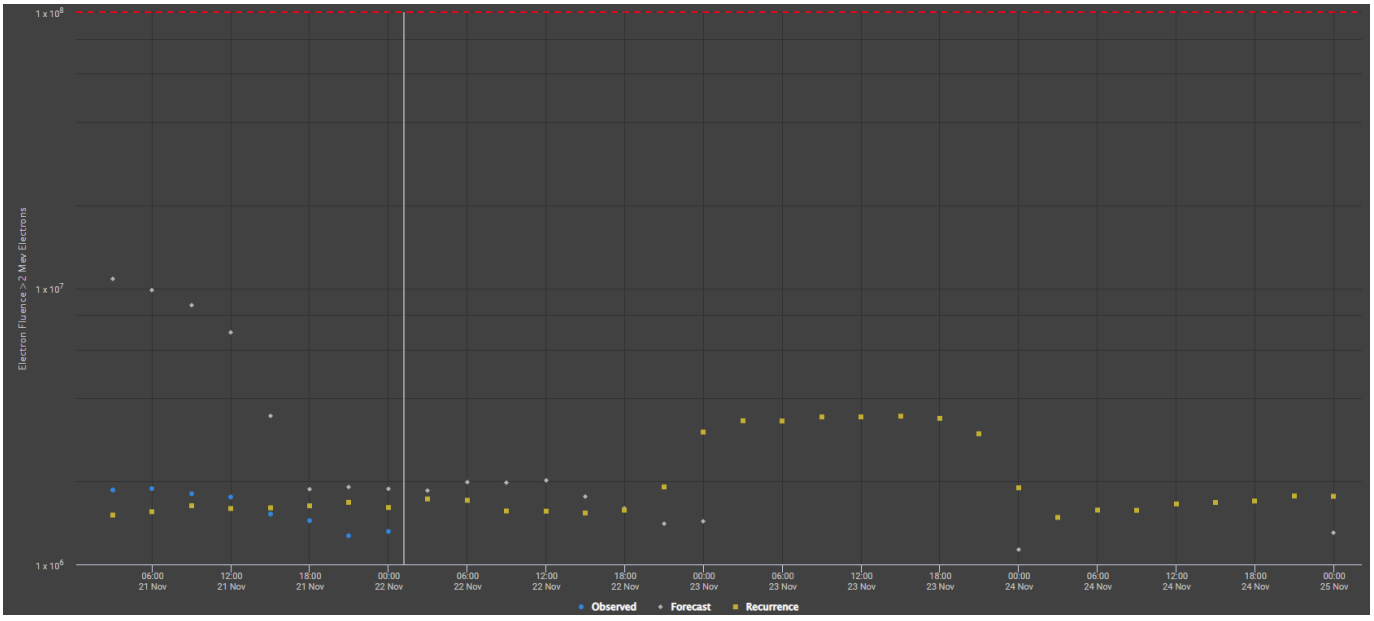
High Energy Electrons (≥ 2MeV)

Electron flux levels at GEO have been sitting at Background levels and are expected to continue to do so. This is likely due to increased solar winds from the connection to CH93- which causes the Van Allen belt to be compressed during the start of the period. From Day 3 (23 Nov), electrons may temporarily increase as the Van Allen belt expands back to the location of GEO. Towards the end of the period, any connection to CH94- may see electron levels again becoming suppressed at GEO.

The initial values unlikely to be of sufficient magnitude to trouble the Active 24-hour integrated threshold - no persistent feature on the disc has resulted in Active fluence. MOSWOC REFM output viewed as providing reasonable guidance at present.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM output.



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